Support building materials with low embodied greenhouse gas emissions as way to keep working forests as forests

Background: Embodied Greenhouse Gas Emissions are the emissions associated with the extraction, processing, transportation, construction and disposal of materials. It is very closely associated with embodied energy, which aggregates the total amount of energy used in the above-mentioned stages. Until fairly recently it was assumed that embodied energy/embodied GHG emissions of building materials were minimal compared to the energy used during the operational life of a building. However, numerous studies have concluded that embodied energy of building materials are equivalent to many years' worth of operating energy. For example, Perez-Garcia et al (2005) found that embodied energy accounted for over 10% of the total energy consumed during the life of a house. Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) found that embodied energy is equivalent to roughly 15 years of operating energy (Reardon et al 2005). This impact becomes more significant as efficiency increases in operating energy.

Proposals for encouraging use of building materials with low embodied greenhouse gas emissions

1) Incorporation of LCA into ~~green building standards~~USGBC's LEED Standard

There are a number of life cycle assessment (LCA) tools that can look at the embodied energy, along with other environmental impacts such as toxic releases to air, toxic releases to water and solid waste, of materials used during building construction. These tools have been incorporated into some green building rating systems[1], but not all.

Currently Washington State has a number of legislative requirements for exclusive use of Leadership in Energy and Environmental Design (LEED) Green Building Rating System in public buildings.[2] The LEED system does not include embodied greenhouse gas emissions, but a proposal, "LCA into LEED" is being worked through the U.S. Green Building Council's Material Resources group. There are plans to start a pilot program in the fall of 2008 and submit for balloting after the USGBC is confident the program can work (expectation this will be at least 12 months).

Proposed Recommendation 1: Washington State (Governor or appropriate agency)~~, I like the Governor as the spokesperson for the state to other non-state organizations)~~ should strongly urge USGBC and other entities that have green building standards to adopt the

[1] Building Research Establishment (BRE) Green Guide to Specification (http://www.thegreenguide.org.uk/) has been using a life cycle assessment (LCA) environmental profile tool for over a decade. The Green Globes environmental assessment and rating system for commercial building launched a LCA environmental profile tool in 2007..

[2] Executive Order 05-01 requires LEED silver standards for public buildings in Washington. The state's High-Performance Public Buildings law (Chapter 39.35D RCW) requires all new state-funded facilities over 5,000 sq. ft. to meet green building standards, with specific requirements that major office and higher education facility projects achieve LEED Silver certification. In addition, all new K-12 schools are required to meet either the Washington Sustainable Schools Protocol (WSSP) or LEED certification.

~~proposed "~~LCA into ~~LEED,"~~their standards. ~~or adopt legislation that encourages consideration of embodied greenhouse gas emissions in green building standards.~~

2) Incorporation of LCA and Washington climate incentives into all green building standards.

The Group acknowledges there are a number of different green building standards but does not have consensus on allowing the option of more than one standard's use in public buildings as currently mandated by Chapter 39.35 RCW High-performance public buildings. In as much as the state intends to encourage the adoption of green building standards for all buildings (commercial/residential, new/renovated), the Group encourages the following action.

Proposed Recommendation 2:

a. The state should actively encourage all green building standards to recognize embodied emissions/LCA. Materials and Resource credits usually account for 10-20% of total points in green building standards. Without including embodied emissions/LCA, these credits cannot appropriately differentiate the climate benefits of various materials.

b. The state should encourage green building standards to recognize and reward the use of bio-based materials, instead of only rapidly renewable bio-based materials. Washington State forests are highly productive and provide significant wildlife habitat, soil stability, and carbon sequestration benefits. Washington State should support efforts to maintain or support this sink by providing an economic incentive for keeping working forests as forests.

c. The state should encourage the ~~promotion~~ harmonization of green building standards ~~in general~~ as a way to boost consideration of energy efficiency, environment and climate. There are currently a number of green building standards in Washington. Harmonization of these standards will allow for increased consumer assurance and clarity within the building industry itself. ~~The state should encourage many competing standards while they are in their infancy but work to encourage harmony into a robust consensus based standard.~~

Formatted: Indent: Left: 0.25", Hanging: 0.25"

~~**Revisions to the state building code**~~

~~Chapter 19.27A RCW[3] requires amendment of the state building code to address energy efficiency, but the statute does not require consideration of embodied greenhouse gas emissions.~~

~~**Proposed Recommendation 2:** The appropriate state agency should ask Legislation should be adopted which requires the state building code council to adopt revisions of the state building code which allow and encourage the substitution of low embodied greenhouse gas materials (e.g. wood and agricultural products) for building materials with higher embodied greenhouse gas emissions, where product substitution is consistent with promoting the health, safety and welfare of building occupants and users and the public generally. If the council is not amenable to this suggestion then legislation should be passed directing the council to adopt such revisions to the building code at their next regular rule update.~~

~~[3] http://apps.leg.wa.gov/rcw/default.aspx?cite=19.27A~~

3) Allowance for the use of low embodied greenhouse gas building materials as a potential mitigation measure under SEPA

Proposed Recommendation 3: Legislation or regulations should be adopted providing that the impacts from embodied greenhouse gases should be considered in environmental reviews of construction projects conducted under the State Environmental Policy Act (SEPA) and that substitution of wood and agricultural products for construction materials with higher embodied greenhouse gas emissions should be considered under SEPA as a potential mitigation measure for adverse climate impacts. To implement this recommendation, tools could be developed or adopted ~~The ATHENA EcoCalculator, which is used~~ to determine ~~average embodied emissions in the King County SEPA GHG Emissions Worksheet Version 1.7 (12/26/07)[4] can be used~~ and~~to~~ quantify the emissions savings by using low embodied emissions materials. (see "LCA tools" below ~~background~~ for more information)

4) Carbon labeling of building materials

Currently a consumer has no way of knowing the relative greenhouse gas emissions associated with the material, manufacturing, and transportation of the products they buy.

Proposed Recommendation 4a: Product Certification Program Development. Enabling legislation should be passed allowing for the development of a voluntary labeling system for building materials that will account for total embodied greenhouse gas emissions. This program would, through a clear and consistent label,indicate to the consumer the total embodied greenhouse gas emissions during the life cycle of a particular product. The development of this program should avoid being unduly burdensome and should build off of existing programs wherever possible (e.g. ATHENA's EcoIndicator calculator).

The enabling agency (Ecology) would have the authority to adopt and implement a standard and product certification program to verify that building materials and other products are sourced, manufactured, and managed in a manner that is consistent with existing state rules, the state's existing environmental priorities, green building standards, and other existing product/material certification schemes. A stakeholder process would be used to advise the department on the development of the program. The legislation would also provide authority for the agency to develop a logo to be used on compliant products and to recover costs for providing the service. . ~~Legislation should be passed requiring labeling of building materials that includes total embodied greenhouse gas emissions. A carbon labeling scheme program would indicate to the consumer the total embodied carbon greenhouse gas emissions during the life cycle of a particular product. The design of effective labels and systems should avoid being unduly burdensome and should build off of existing programs wherever possible. Life cycle assessments have already been done on many building materials (e.g. see, for example, ATHENA's EcoIndicator calculator) and, in the beginning, these results can be included in~~

[4] Available at: www.metrokc.gov/ddes/forms/SEPA-GHG-EmissionsWorksheet-Bulletin26.pdf

~~literature without having to do extensive LCAs on individual products. Eventually a carbon labeling program could be developed to include participation by manufacturers and product lines.~~

Formatted: Strikethrough

Proposed Recommendation 4b: The appropriate state agency should adopt, as an element of the state's procurement policies, a significant degree of preference for procuring building products that are (1) carbon labeled and (2) have low carbon (i.e., low embodied GHG) content.
~~*[pending consultation with the Beyond Waste Workgroup] It should not be pending- this was the recommendation of the workgroup.*~~

Additional background:

Studies that compare embodied greenhouse gas emissions of various building materials.

Study	*Wood (kg CO_2/m^2living space)*	*Concrete (kg CO_2/m^2living space)*	*Concrete vs. Wood (% Change)*
Noren, J. 2001.	30	400	1233%
Trusty, Meil 1999			
Meil et al 2002	280	420	50%
Glover 2001	290	510	76%
Buchanan and Levine 1999	220	345	57%
Borjesson and Gustavsson 2000[5]	~40	~60	~50%

Study	*Wood (kg CO_2/m^2living space)*	*Steel (kg CO_2/m^2living space)*	*Steel vs. Wood (% Change)*
Trusty, Meil 1999	280	340	21%
Meil et al 2002	207	309	49%
Glover 2001	290	690	137%
Buchanan and Levine 1999	220	352	60%

On a large scale, the selection of building material makes a significant difference. For example:

- If 1.5 million housing starts in the U.S. used wood-framed houses rather than non-wood building systems, 9.6 million metric tons (mt) CO_2e per year would be kept out of the atmosphere. This savings is equivalent to keeping roughly two million cars off the road for one year (Miner et al, 2006)

[5] Converted from whole building (apartment building with 1040 m^2 living space) to per m^2 living space

- Using wood-framed housing in the 1.7 million housing starts in Europe[6] would save 35-50 million mt CO_2e, which would be enough to contribute 11-16% of the emissions reduction needed for Europe to meet the Kyoto requirement (Eriksson 2003).
- A 17% increase in wood usage in the New Zealand building industry could result in a reduction of 484,000 mt CO_2e. This reduction is equivalent to a 20% reduction in carbon emissions from the New Zealand building industry and roughly 2% of New Zealand's total GHG emissions (Buchanon and Levine 1999).
- Goverse et al (2001) concluded that an increase in the use of wood could cut CO_2 emissions from construction by almost 50% compared to Dutch traditional construction.

LCA Tools

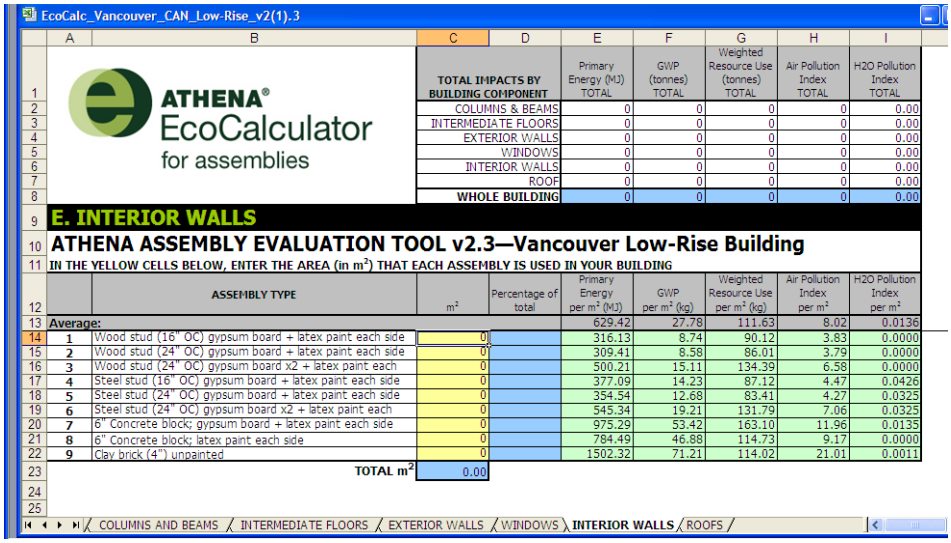
ATHENA EcoCalculator[7]- The ATHENA EcoCalculator for Assemblies compiles greenhouse gas emissions for different material building assemblies (e.g. exterior walls, roofs, windows, floors, interior walls) based on detailed life cycle assessments using the ATHENA Impact Estimator for Buildings. The ATHENA Impact Estimator, in turn, uses data from the US Life Cycle Inventory Database and ATHENA's own datasets (see http://www.athenasmi.ca/tools/docs/EcoCalculatorFactSheet.pdf for more detail). The EcoCalculator is used by architect firms and universities and can be used for new construction, retrofits and major renovations in industrial, office or residential design. ATHENA is used to determine average embodied emissions in the King County SEPA GHG Emissions Worksheet Version 1.7 (12/26/07)[8].

The ATHENA EcoCalculator calculates the average embodied greenhouse gas emissions, *per square foot (square meter)*, for each building assembly[9]. This then can be scaled up to the square footage of an average house. A builder can then enter the square footage of a particular material assembly type that will be used in the building. The embodied greenhouse gas emissions will be automatically calculated in ATHENA and summed across all assemblies (e.g. floor, interior wall, exterior wall, roof, windows).

The difference in embodied greenhouse gas emissions between the average building assembly and the builder's assembly can be readily quantified.

Here is what the ATHENA EcoCalculator looks like:

[6] Currently only 5% of new construction in Europe uses wood framing. *[we should ask Edie for the reference for this statistic.]*
[7] Available free of charge at: http://www.athenasmi.org/
[8] Available at: www.metrokc.gov/ddes/forms/SEPA-GHG-EmissionsWorksheet-Bulletin26.pdf
[9] Note: this average should not be a weighted average based on current market share but rather the physical average of different options of assembly types. It is important to recognize that current market share today does not lock-in current market share in the future, and the benefits should actually accrue to the lowest carbon footprint materials.



EcoCalc_Vancouver_CAN_Low-Rise_v2(1).3

ATHENA® EcoCalculator for assemblies

TOTAL IMPACTS BY BUILDING COMPONENT	Primary Energy (MJ) TOTAL	GWP (tonnes) TOTAL	Weighted Resource Use (tonnes) TOTAL	Air Pollution Index TOTAL	H2O Pollution Index TOTAL
COLUMNS & BEAMS	0	0	0	0	0.00
INTERMEDIATE FLOORS	0	0	0	0	0.00
EXTERIOR WALLS	0	0	0	0	0.00
WINDOWS	0	0	0	0	0.00
INTERIOR WALLS	0	0	0	0	0.00
ROOF	0	0	0	0	0.00
WHOLE BUILDING	0	0	0	0	0.00

E. INTERIOR WALLS

ATHENA ASSEMBLY EVALUATION TOOL v2.3—Vancouver Low-Rise Building

IN THE YELLOW CELLS BELOW, ENTER THE AREA (in m²) THAT EACH ASSEMBLY IS USED IN YOUR BUILDING

		ASSEMBLY TYPE	m²	Percentage of total	Primary Energy per m² (MJ)	GWP per m² (kg)	Weighted Resource Use per m² (kg)	Air Pollution Index per m²	H2O Pollution Index per m²
Average:					629.42	27.78	111.63	8.02	0.0136
1		Wood stud (16" OC) gypsum board + latex paint each side	0		316.13	8.74	90.12	3.83	0.0000
2		Wood stud (24" OC) gypsum board + latex paint each side	0		309.41	8.58	86.01	3.79	0.0000
3		Wood stud (24" OC) gypsum board x2 + latex paint each	0		500.21	15.11	134.39	6.58	0.0000
4		Steel stud (16" OC) gypsum board + latex paint each side	0		377.09	14.23	87.12	4.47	0.0426
5		Steel stud (24" OC) gypsum board + latex paint each side	0		354.54	12.68	83.41	4.27	0.0325
6		Steel stud (24" OC) gypsum board x2 + latex paint each	0		545.34	19.21	131.79	7.06	0.0325
7		6" Concrete block; gypsum board + latex paint each side	0		975.29	53.42	163.10	11.96	0.0135
8		6" Concrete block; latex paint each side	0		784.49	46.88	114.73	9.17	0.0000
9		Clay brick (4") unpainted	0		1502.32	71.21	114.02	21.01	0.0011
		TOTAL m²	0.00						

COLUMNS AND BEAMS / INTERMEDIATE FLOORS / EXTERIOR WALLS / WINDOWS / INTERIOR WALLS / ROOFS

References:

Borjesson, P. and L. Gustavsson. 2000. Greenhouse gas balances in building construction: wood versus concrete from life-cycle and forest land-use perspectives. *Energy Policy* 28:575-588.

Buchanan, A.H. and S.B. Levine. 1999. Wood-based building materials and atmospheric carbon emissions. *Environmental Science and Policy.* 2: 427-437.

Eriksson, P.E. 2003. *Comparative LCA:s for wood construction and other construction methods- Energy use and GHG emissions.* A study compile on behalf of the Swedish Wood Association, now part of Swedish Forest Industries Federation, Stockholm. http://www.Svenskttra.org/pub/lca.pdf (accessed Feb 28, 2007).

Glover, J. 2001. Which is better? Steel, concrete or wood. A comparison of assessments on three building materials in the housing sector. Fourth year thesis, Department of Chemical Engineering, University of Sydney.

Goverse, T, M. Hekkert, P. Groenewegen, E. Worrell, R. Smits. 2001. Wood innovation in the residential construction sector; opportunities and constraints resources. *Conservation and Recycling* 34: 53-74.

Miner, R. 2006. The 100-year method for forecasting carbon sequestration in forest products in use. *Mitigation and Adaptation Strategies for Global Change.* Published online 20 May 2006. Springerlink.

Noren, Jarne-hammar. 2001. Environmental Assessement of Trahus. Report No P0101002. Swedish Institute of Wood Technology Research.

Perez-Garcia, J., B. Lippke, D. Briggs, J. Wilson, J. Bowyer, and J. Meil. 2005. The environmental performance of renewable building materials in the context of residential construction. *Wood and Fiber Science* 37 CORRIM Special Issue: 3-17.

Reardon, C., S. White, C. McGee, S. Shackel, B. Slapp. 2005. *Your Home.* Produced for the Australian Government by the Institute for Sustainable Futures, University of Technology, Sydney.

Thormark, C. 2006. The effect of material choice on the total energy need and recycling potential of a building. *Building and Environment* 41:1019-1026.

Trusty and J. Meil. 1999. Building Life Cycle Assessment: Residential Case Study. Athena Sustainable Material Institute.